Discussion Papers No. 509, July 2007
Statistics Norway, Research Department

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Adapt or withdraw?
Evidence on technological changes and early retirement using matched worker-firm data

Abstract:
Older workers typically possess older vintages of skills than younger workers, and they may suffer more from technological change. Experienced workers may nevertheless have accumulated human capital making them suitable for adopting new technologies. On the other hand, to adjust to new technologies, workers must invest in training. This may not be worthwhile for the oldest workers, and technological change may thus induce early retirement. If technological change occurs often, workers will continuously invest in training, which may insulate them from the negative effect of technological change. We exploit the approach by Bartel and Sicherman (1993) to identify this effect by estimating the retirement response to technological change. We examine two hypotheses about the effects of technological changes on early retirement for workers from the age of 50 to the mandatory age of retirement at 67. First, we examine whether workers in firms with higher rates of anticipated technological change retire later than workers in firms with lower rates of technological change. Second, we examine if unanticipated technological change is positively correlated with earlier retirement. We use a matched employer-employee data set with a rich set of controls for worker, firm and local labour market characteristics, and firm level measures of anticipated and not-anticipated technological change. We find a negative correlation between early retirement and anticipated technological change only for the oldest male workers (62 to 66). Further, we find a higher probability of transition to retirement for workers above 60 for firms introducing new process technologies.

Keywords: Technological changes, early retirement

JEL classification: J26,O33

Acknowledgement: We have benefited from comments from Terje Skjerpen and seminar participants at Statistics Norway and the Norwegian School of Economics and Business Administration. The research project has received financial support from the Research Council of Norway (grant 156110/S20).

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1. Introduction

The introduction of new technologies over the last decades, has certainly increased the productivity and welfare of the working population in the Western countries. The introduction of new technologies is also found to affect the structure of employment, and in particular technological change has been found to be biased against low-skilled workers (Machin and van Reenen, 1998; Krueger, 1993; Acemoglu, 1998; Author, Katz, and Krueger, 1998; Salvanes and Førre, 2003). Thus, the burden of the costs of this productivity gain is found to be unequally distributed across groups of workers. The question we ask in this paper is whether new technology is biased against the work prospectives of older workers. This issue is all the more timely since in Europe the employment rate of older workers has been declining over time. For workers older than 55 it is below 50 percent, while it is above 50 percent in the US. Most of this change is probably attributed to factors affecting labour supply, such as generous benefits (Gruber and Wise, 2004).[1] The present paper focuses on whether changes on the demand side play a role in explaining the change in employment prospect of older workers by analyzing the effect on retirement of technological change.

The prediction from theory is not clear when it comes to the effect on demand for older workers. Older workers typically possess older vintages of skills than younger workers. This is because their investment in formal education typically is of an older date, and that they have accumulated human capital on the job over a longer period. Accordingly, their skill mix is of an older date, less suited to match new technologies. Hence, with respect to depreciation of human capital it is likely that older workers suffer more from technological change. Weinberg (2005) argues on the other hand that experienced workers nevertheless have accumulated human capital that makes them suitable for adopting new technologies. On the other hand, to adjust to new technology workers must invest in training to acquire technology-relevant skills. The investment decision will among other factors depend on the time left to planned or mandatory retirement. For older workers the investment in training may not be worthwhile if the time left to retirement gives a too short time horizon to make the investment profitable. The consequence may be withdrawal from work earlier than planned. Even if workers of all ages have similar ability to adapt to new technologies, the period to recover costs of investments in human capital may be too short for older workers.[2]

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[1] It is of course not clear whether supply or demand forces are the more important since most probably much of the changes in benefit schemes for early retirement has been implemented to accommodate changes taking place in firms' demand for workers.

[2] There is some support for the fact that the ability to adopt computer use is not so dependent on age (or perhaps the net effect of the vintage human capital effect and experience effect), in that the relationship between computer use and age seems to be quite flat with a slightly more frequent use by the age groups 30-49 (Weinberg, 2005; Friedberg, 2003, Borghans and ter Weel, 2002). Weinberg (2005) also finds the age-computer use profile differs by education; experience to a certain extent substitutes for formal education.

From this reasoning, one would expect that the probability of leaving the labour market is increasing with age when new technology is introduced to the firm, *ceteris paribus*. However, the timing of the retirement decision will also depend on the age of the accumulated human capital through on-the-job training. We exploit the approach suggested by Bartel and Sicherman (1993) to identify this effect by estimating the retirement response to technological change dependent on how often it occurs. The idea is as follows: Some firms are characterized by high rates of continuous technological changes. In such firms, workers have to update their human capital continuously. As a consequence, older workers who have chosen to stay in such firms probably have a less obsolete human capital than workers of the same age in other firms. They are more able to take advantage of the higher productivity, that follows from technological changes without a large new investment in human capital. We may therefore expect workers in such firms to retire later. This is a combined effect of technical change and selection of workers into such firms. In firms where technological changes are more extraordinary, the required investment in new skills following a technological change may be larger and more costly. All else equal, this will make retirement more attractive.

In our approach we analyze the effects of technological change on early retirement using firm-level data for expected and unexpected technological change. We use a very rich data set consisting of a rich matched worker-firm dataset with firm-level indicators of technological change in addition to other firm controls that are relevant for workers retirement decision both at the worker (wealth, indicator for health etc), firm (downsizing or not), and local labour market level (local unemployment rate, the degree of early retirement in the local labour market). Other papers within this literature mainly rely on indirect indicators of technological change such as total factor productivity (TFP) growth measured at a rather aggregate (two-digit) industry level. Firms, even within narrowly defined industries, may differ with respect to rates of technological changes, and using measures of technological changes at the firm level accounts for this possible heterogeneity (Haltiwanger, Lane and Spletzer, 2000; Doms, Dunne and Troske, 1997). We use investments in machinery and equipment over a period of time as an indicator of normal or expected technological change, while introduction of new process technology (conditional on investment level) is an indicator of extraordinary or unexpected technological change.

Our empirical analysis gives support to a hypothesis that technological changes *in the firm where the worker is employed* do affect retirement decisions of older workers. Older male workers in their sixties, with only very few years left before mandatory retirement age, in firms with higher "normal" rates of technological changes retire later than workers in firms with lower rates of technological changes. For women we do not find any effect. In addition, we find that *some of the oldest workers* in firms changing process technology retire earlier than similar workers in firms with no change in process technology. Hence, older workers in firms who experience an “extraordinary” technological change retire earlier. Our results are in line with those obtained using more crude measures of technological change, and with less worker, firm, and labour market controls, such as Bartel and Sicherman (1993).

The next section will give a short review of some earlier studies on technological changes and early retirement. In section 3 we give a brief definition of technological changes, while section 4 presents a description of some important facts about the early retirement options in Norway as well as the pattern of early retirement in Norway. Section 5 presents the empirical specification, and section 6 describes the sample and some of the data in more depth. Section 7 presents the results, and section 8 concludes.

2. Literature on technological changes and retirement

The literature on technological changes and older workers' retirement from the labour market is relatively small. There is a larger, parallel literature on the impact of technological change on wages of older workers and particularly the experience premium, which is strongly related (see for instance Weinberg, 2005; Borghans and ter Weel, 2002, 2006). The earliest study is Bartel and Sicherman (1993). Based on the theoretical human capital model in Ben-Porath (1967), they formulate two hypotheses on the relationship between general technological changes and early retirement. Their line of argument goes as follows: Some of the existing human capital is made obsolete by technological change. Training is required to reap the benefits of technological change. The effects on retirement behaviour depend on the individual costs and benefits associated with the technological change given an optimal response with respect to investment in training.

Their first hypothesis concerns *expected* or continuous technological change. Their prediction is that workers in firms or industries with high rates of technological change retire later than workers in firms or industries characterized by low rates of technological change, provided that firms with high rates of technological change offer more on-the-job training to take advantage of the new technology. More on-the-job training, given the level of technological change, implies a steeper wage profile and makes it more attractive to remain in work. However, technological change depreciates existing human capital. All else being equal, this reduces the return on investment in training. The net effect on training is ambiguous. Firms with higher rates of technological change attract workers who are able to benefit more from technological change. Among older workers, these will be people who have high returns on investment in training and/or people who plan to remain in longer in work.

Their second hypothesis relates to sudden or unexpected technological change. Workers respond to the continuous or normal rate of technological change by adjusting their levels of continuous investment in training. A sudden technological change leads to an acute depreciation of human capital, implying a wage loss that can only be avoided through investment in human capital (or through a change in planned investment). For older workers, the returns to such investments are lower, because their remaining working lives are shorter. Sudden technological change therefore increases the retirement probability of older workers.

Bartel and Sicherman (1993) test their hypotheses by using data from the National Longitudinal Surveys of Older Men for the period 1966–1983. Their measure of technological change is based on the growth in TFP at the two-digit industry level. Continuous technological change is measured by using a 10-year mean of TFP growth. Unexpected technological change, or 'shocks', is measured by using a standardized annual deviation from the normal rate. They estimate a binary logit model of retirement, and control for a large number of retirement-relevant individual characteristics as well as technological change. The results support both hypotheses. Older workers in industries with high rates of technological change retire later than older workers in industries with low rates of technological change. In addition, unexpected increases in technological change are positively correlated with early retirement.

Ahituv and Zeira (2001) develop a theoretical overlapping generations model that incorporates technological change to illustrate the links between technological change and early retirement. The predictions of the model are consistent with the hypotheses stated above. That is, the closer a worker is to the planned retirement age, the less worthwhile is training because of the short time left in work to reap the benefits of the investment in training required to learn the new technology. This may in turn lead to an earlier withdrawal from the labour market. The authors also note that the productivity-enhancing effect of technological change on wages may generate incentives to stay in work longer. By using five-year TFP industry averages to measure technological change, and by using data from the Health and Retirement Study, they find that technological change has a negative effect on the labour supply of older workers. However, for those remaining in work, technological change has a positive effect on wages.

A similar analysis was undertaken by Friedberg (2003), who investigates the relationship between computer use and retirement. Using data from the Current Population Survey, she shows that those who use computers retire later than those who do not use computers. This may be because workers using computers have planned to retire later than nonusers, or because those planning to retire later choose to invest in computer knowledge. Using data from the Health and Retirement Study, she also finds indications that impending retirement does not generate incentives to learn to use computers because there is insufficient time before retirement to reap the benefits. This analysis differs from those of Bartel and Sicherman (1993) and Ahituv and Zeira (2001) by analyzing the use of one type of equipment, namely computers, rather than investigating technological change in general.

From the review of these studies, we can draw some conclusions. There seems to be a relationship between technological change and early retirement. Workers in industries with high rates of technological change seem to retire later than do workers in industries with low rates of technological change. This may be because workers in industries with high rates of technological change have planned to work longer than workers in industries with low rates of technological change, and hence train more than workers planning to retire earlier. The studies also indicate that unexpected technological change is negatively correlated with labour force participation. Furthermore, Ahituv and Zeira (2001) find evidence of a negative aggregate effect of technological change on early retirement.

3. How should we measure technological change?

In the literature, several measures of technological change have been used. One commonly used measure is TFP. Ideally, TFP measures disembodied technological change, that is, increases in output that are unrelated to the use of more inputs or changes in the quality of inputs. TFP is measured as the residual of the difference between changes in output and the changes in an index of inputs between two periods. TFP may reflect the effects of all factors not captured by measured inputs, but empirical studies show that TFP is related to more direct measures of technological change, such as R&D intensity; see Lichtenberg and Siegel (1991), Geroski (1994), and Sterlachinni (1989).

Both Bartel and Sicherman (1993) and Ahituv and Zeira (2001) measure technological change by using TFP growth at a highly aggregated industry level. Hence, they assume that firms within these industries have the same rates of technological change. A consistent finding in many studies at the firm level is that there is much heterogeneity between firms, even within narrowly defined industries, in many respects. *A priori*, there is no reason to believe that this is not the case with respect to technological change. For Norwegian manufacturing, to which our data relate, Møen (1998) shows that there is a high degree of heterogeneity in firm-level TFP growth, even within narrowly defined industries. This indicates that industry-level TFP growth may not reflect the technological change experienced by individual workers and firms in the industry, which is the appropriate measure to use when studying how technological change affects retirement behavior. Since TFP growth is measured as a residual, it may be influenced by other factors than technological change. Hence, one should use indicators that measure changes in the technology facing workers that are available at the firm level.

One obvious candidate is R&D intensity in the firm. Technological change in a firm is often, but not necessarily, fundamentally linked to research activity. First, not all technological change is related to the firm's own R&D activity. The technology faced by workers may change substantially even if there is no R&D in the firm because, for example, of the use of new equipment developed by others. Second, not all R&D activity in a firm implies changes in the technology facing workers. Much R&D is directed towards developing new products, which may or may not influence the production process.

Our measures of technological change (details are given in section 6) attempt to capture changes affecting the working environment in the firm. Technological change typically requires the acquisition of new machinery and equipment. To the extent that the technology facing workers is embodied in the equipment that workers use, investment in these capital goods may be an indicator of the rate of technological change. To measure the level of 'continuous' or expected technological change, we need an indicator of the normal level of acquisitions in the firm. The average investment rate or the median investment rate at the firm level over the period we are analyzing may be used to proxy the normal level of acquisitions of machinery and equipment, which captures the expected rate of technological change in the firm. We use the median investment rate to measure the normal level of technological change.

An additional measure of technological change is an indicator of whether the firm has implemented new process technologies. Information on this can be found in R&D surveys. Whereas investments in machinery and equipment may reflect the normal rate of technological change, changes in process technology may reflect extraordinary changes in technology, particularly when we condition on the investment rates in capital equipment, in the econometric analysis. Although changes in process technology may not be completely unexpected by workers in a firm, we assume that this variable is an appropriate measure of the implementation of new technology in the firm. Generally, the distinction between the operationalization of unexpected (extraordinary) and expected (normal) technological change is ambiguous. Although it is arguably the case that changes in process technology mainly reflect unexpected changes and that the normal investment rate broadly reflects expected changes, one should be cautious in interpreting the results as the estimated effects of different kinds of changes.

4. Early retirement in Norway

The official retirement age in Norway is 67 years. At the age of 67, everyone has the right to withdraw from the labour market and receive an old age pension. Between 67 and 70, the old age pension is reduced according to labour income earned. For workers in some professions, such as the police and armed services, the retirement age is below 67 years.

Many retire before the official retirement age, and there are several possible ways of leaving employment to retire. The largest early retirement scheme involves the disability pension. People who lose their ability to earn income may, after medical examination, receive a disability pension. More than 300,000 persons were on a disability pension in 2005, and the number has increased quite strongly over the past decade. The total number of employed persons was 2.3 millions in 2005, so the disability pension represents a common exit route from the labour force.

A special early retirement scheme, the AFP, was implemented in 1989. This was the result of negotiations between trade unions and employer organizations. The scheme allows employees in establishments covered by the scheme to retire before the official retirement age. In addition, there are individual requirements regarding previous employment and income. That is, one must: i) have an annual income of at least NOK 60,000 (USD 10,000) in 2005 prices in the year of retirement and in the preceding year; ii) have earned pension points (that is, have been working) in the national social insurance scheme for at least 10 years after the age of 50; and iii) have had an average income of at least NOK 120,000 (USD 20,000) in 2005 prices in one's 10 highest-earning years since 1967. The retirement age under the AFP was originally 66 years. It has been reduced several times. Since 1998 it has been at 62 years. Ordinary old-age pension income from the age of 67 is not affected by being in the AFP. Because delaying or not having AFP income does not increase pensions received later, the scheme gives incentives to retire at the first opportunity. At the end of 2005, there were 37,395 persons on an AFP pension.

The disability pension and the AFP represent the two main early retirement schemes. In addition, unemployment and rehabilitation may represent early retirement for older people. Although people in both groups intend to return to work, in practice few do so. In addition to these schemes, there are various private arrangements that allow employees to withdraw from work before the age of 67. Given that there are many ways to move from work into 'official' early retirement and retirement schemes, a more comprehensive definition of early retirement is required for our empirical analysis. This is because our main purpose is to study how technological change affects older workers who exit from the labour market, rather than to analyze the effects of the exit routes from work into retirement.

4.1 Patterns of retirement

We consider the retirement patterns of older workers. In this context, 'older' is defined as between 50 and 66 years of age. Figures 1 and 2 below cover the period 1994–2001. The sample consists of all persons in Norway who were aged 50–66 in this period and who were in work when first included in the sample, i.e. either in 1994 or when they reached age 50. Constructing the sample in this way implies that the observations cannot be interpreted as being equivalent to hazard-rate figures. This is because, for those who are younger, sampled individuals are those who are in work when younger, whereas for those who are older, we condition on them being in work at an older age. For example, for a person aged 51, the rates are conditional on being in work at the age of 50, while for someone aged 65, the rate is a weighted mean of the rates for those who were between 58 and 64 and in work in 1994. However, cohort-specific hazards exhibit a similar pattern, and we prefer this more compact exposition. The figures reveal that disability pensions and AFP pensions dominate. There is a large increase in the share of individuals on AFP pensions from the age of 62 to the age of 66. The share of those having exited from work to disability pension increases almost linearly with age. Among 66-year-old males, 16 percent of the sample is on a disability pension. For females, the share is 18 percent. For the AFP pension, the corresponding shares are about 33 percent for men and nearly 27 percent for women. As shown in Appendix C, the share of the eligible age group on AFP has increased over time, to some degree at the expense of the share on disability benefits. The share of 'younger olds' on a disability pension has increased over time.

The group 'other' consists of persons not belonging to any of the other five groups. These may be individuals who remain at home, individuals with private pensions, and persons in occupations with a lower retirement age than the official one. For men, just over 12 percent of those aged 66 are in this group, while more than 14 percent of women of the same age are in this group. Less than one percent were unemployed throughout the period. Few people of any age are on temporary disability pensions or undergoing rehabilitation.

Our study covers manufacturing. The corresponding figures for individuals (having been employed) in the manufacturing industry are shown in Figures 3 and 4. Similarly to the whole economy, disability pensions and AFP pensions dominate. For 66-year-old men, the share of those on an AFP pension is nearly 46 percent, which is higher than for the economy as a whole. Around fifteen percent have a disability pension, and this is similar to the share for the whole economy. For women, the share of 66-year-olds with an AFP pension is 34 percent; 16 percent get a disability pension. For both men and women, unemployment increases from the age of 60. The group 'other' has a lower share out-of-work women and men than for the whole economy. This may be because occupations with lower retirement ages are outside manufacturing. It may also be that, in manufacturing, a higher share of workers than in the rest of the economy has the option to retire with an AFP pension.

Details of the construction of our sample are given in Section 6. In Figures 5 and 6, we show the shares of those who are out of work for our sample, which covers total manufacturing. Comparing the manufacturing industry with our sample shows that the shares with disability and AFP pensions are higher in our sample. Otherwise, the patterns are similar to manufacturing as a whole. However, there are fewer in the group 'other' in the sample. Because our sample includes only joint-stock companies, most small firms are excluded from the sample. Larger firms are more likely to be affiliated to the AFP scheme. This may explain why the share in the group 'other' is lower in our sample than for the whole manufacturing sector.

The preceding discussion established that there are several possible ways into early retirement. The AFP and disability pension are in practice 'absorbing states', in the sense that few return to work from these states. In Appendix A, we show simple survival rates for individuals in unemployment, rehabilitation, and the group we have labeled 'other'. This last group comprises individuals who are out of work but are not in any of the other out-of-work states. When an individual over the age of 50 is in one of these states, the probability of leaving that state to work is quite low, although this depends on the state. Most individuals on rehabilitation either continue on rehabilitation or end up receiving a disability pension. For unemployed individuals, going back to work is more likely but this probability decreases with age. The same is the case for the group 'other'. Specifically, many women stay in the group 'other', many of whom are probably staying at home.

5. Econometric specification

Our econometric analysis focuses on individuals observed in work. We then estimate the probability of retiring conditional on having work in one or more of the three last years. Assume that we have the following model

$$y^*_{ijt} = \boldsymbol{\alpha}\sum_{52}^{66}\mathbf{Agedum_{it}} + \boldsymbol{\beta}\sum_{51}^{66} Age_{it} \times MInvest_j + \boldsymbol{\varphi}\sum_{51}^{66} Age_{it} \times Pinvest_{jt} + \mathbf{x_{it}}\boldsymbol{\psi} + z_{jt}\gamma + u_{ijt},$$
$$i = 1,...,N,\ j = 1,...,J \text{ and } t = 1,...,T$$

where *i* is the individual index, *j* is the firm index *t* is the year index. Furthermore, y^*_{ijt} is a latent variable representing individual propensity to work. $\mathbf{Agedum_{it}}$ is a vector of dummy variables; one dummy variable for each age between 52 and 66. All workers aged 50 are left out from the regression since they are all in work, and the dummy variable for the 51 years old is left out to avoid perfect multicollinearity. $\mathbf{x_{it}}$ is a vector of individual-specific variables such as education, dummies for part-time work, net wealth, whether the person is married, health and whether the person is covered by a particular type of early retirement scheme (AFP); and local labour market characteristics; proportion on early retirement in county, local unemployment rate, z_{jt} are the firm level variable we control for; downsizing. Year dummies, two-digit sector dummies as well as industry trends (interactions between year and industry dummies are included). u_{ijt} is a stochastic error term.

The variables of interest are two types of technical change interacted with the age of the worker (Age). Age is measured in a flexible way by including a dummy for each age; 0 for those 50 years of age and a new dummy up to the age of 66. Technical change is measured by two different measures– permanent as measured by median machinery investment over years at the firm level (MInvest) – and the unexpected technical change as measured by adoption of new processes (PInvest).

We do not observe the latent variable directly, but only whether the individual is working or retired. The dependent variable $\mathrm{y}_{\mathrm{ijt}}$ takes on the value 0 if individual *i* in firm *j* is in work at time *t*, and 1 if individual *i*, from firm *j*, is retired at time *t*. Transition from work to retirement occurs when $\mathrm{y}^{*}_{\mathrm{ijt}} > 0$. If we let C comprise all the right-hand side variables in the equation above, and assume that the error terms have identical independent standard normal distributions, $u_{ijt} \mid \mathrm{C} \sim (0,1)$ we have the probit model

$$\mathrm{P}\left(\mathrm{y}_{\mathrm{ijt}} = 1 \mid \mathbf{C}_{\mathbf{it}}\right) = \mathrm{P}\left(\mathbf{C}_{\mathbf{it}}\boldsymbol{\lambda} + u_{ijt} > 0\right) = \mathrm{P}\left(u_{ijt} > -\mathbf{C}_{\mathbf{it}}\boldsymbol{\lambda}\right) = \boldsymbol{\Phi}\left(\mathbf{C}_{\mathbf{it}}\boldsymbol{\lambda}\right)$$

where $\boldsymbol{\Phi}$ denotes the standard normal cumulative density function. So, $\boldsymbol{\Phi}\left(\mathbf{C}_{\mathbf{it}}\boldsymbol{\lambda}\right)$ is the probability of retiring in period *t* conditional on being in work in period *t-1* and/or *t-2* and/or *t-3*.

6. Sample and variable construction

The data used in this study are taken mainly from Norwegian administrative registers for firms and individuals. The use of consistent firm and personal identifiers across registers facilitates the linking of different data sets. Some registers contain both firm and personal identifiers, which enables the creation of linked employer–employee data sets.

6.1 Sample of firms and firm-level variables

The manufacturing statistics are from an annual census covering all establishments in the manufacturing sector. The accounts statistics cover all nonfinancial joint-stock companies. The establishments covered in the manufacturing statistics are aggregated to the firm level and merged with the accounts statistics; see Raknerud *et al*. (2007). This capital database covers all manufacturing joint-stock companies. Data on investment in new capital goods are taken from the manufacturing statistics. The values of investments are in current prices. The stock of capital is taken from the accounts statistics. Originally, the stock values were given in historic-cost prices. We have converted these values into current prices by using price indices for investment in new capital goods. The R&D survey is biannual. We use the surveys from 1997, 1999, and 2001. We use a variable stating whether the firm introduced new or significantly improved production processes during the previous three years, including the year of the survey. This is a binary variable, taking the value of unity if the firm has introduced new or improved production processes, and zero otherwise. When taken together, these data sets provide us with a sample of 4,717 firm-year observations, on 1,626 firms in 1997, 1,648 firms in 1999 and 1,443 firms in 2001.

To measure the level of 'continuous' or expected technological change, we need a measure of the normal level of acquisitions in the firm. The average investment rate or the median investment rate of machinery and equipment at the firm level over the period under study can be used to proxy for the normal level of acquisitions of machinery and equipment, which represents the expected rate of technological change in the firm. We use the median investment rate to measure the normal level of technological change. We use information on investment in machinery and equipment, which comprises machines, tools, equipment, furniture, and cars and other transport vehicles. Throughout, we use the term 'machine capital' for all these capital goods. Investment rates are calculated by dividing the amount of investment in machine capital during the year by the net stock of machine capital at the beginning of the year. The investment rate is zero if there are no investments during a year; the rate is positive when investment exceeds zero. The median investment rate at the firm level is interacted with age to construct age-specific technology variables. We interact the median investment rate with worker age because the relationship between the rate of technological change and the probability of retirement is expected to vary with age, and this effect is expected to be larger at higher ages. Hence, we use a variable for the rate of technological change for each age. The variable takes the value of the product of the age and the median investment rate, and zero otherwise.

Data for process changes are taken from the R&D statistics in Statistics Norway (Statistics Norway, 2004). The R&D statistics come from two surveys: the innovation survey, which is available for 1997 and 2001; and the R&D survey, which is used for 1999. In all surveys, the following question (from the 2001 survey) was asked: "During the period 1999–2001, has your enterprise introduced any new or significantly improved production processes including methods of supplying services and ways of delivering products?"[3] From this, we construct a binary variable that indicates whether the firm has taken into use new processes during the previous three years, including the year of the survey. We interact the variable with age to construct age-specific variables for new process technology in the same way as for the rates of technological change variables described above.

When firms downsize, which lowers the number of employees, workers of different ages may be affected differently, and some older workers may retire. Firms may also offer retirement

[3] From the R&D survey of 2001, question C.2.1 in the questionnaire.

packages when implementing downsizing. Therefore, we include a dummy variable that is unity for firms that downsize, and zero otherwise.

In Table 1, we report descriptive statistics for the firms in our sample. In each year, a minority of firms implemented new technology. The average median investment rates are similar between years and between firms that implemented new process technology and those that did not.

6.2 Individual and local labour market data

We use individual-level data for the period 1994–2001. These data are taken from the FD–TRYGD database in Statistics Norway.[4] This database has detailed information on employment relations and different pensions as well as information on education and incomes at the individual level. The FD–TRYGD database is constructed from administrative registers covering the entire Norwegian population, but we limit our sample to workers between 50 and 66 years of age. We create biannual data files in which individual status is recorded at the end of the year. In this way, we create three cross-sectional data sets. Some firms and individuals are included in more than one of the cross-sectional samples. The total number of observations is 140,920. The observations are distributed fairly evenly across the three years. In Appendix B, we describe the construction of the sample and present an overview of the observations by year.

In our econometric specification, we include age as a conditioning variable. This is because the data on retirement show that the proportion of retired persons increases with age. We construct a dummy variable for each age. Arguably, there is a positive correlation between bad health and early retirement, and in particular transitions to rehabilitation and disability pension. Sick leave is an indicator of bad health. We use data on sick leave beyond two weeks as an indicator of individual health. Controlling for educational levels is important. The propensity to retire early may differ greatly between individuals with different educational levels. Individuals with more education have invested more in their human capital and may have a greater incentive to work longer to reap the benefits of this investment. In addition, individuals with more education may have more interesting jobs. Thus, we expect individuals with more education to retire later.

There may be differences between workers who can retire with an AFP pension and workers who do not have this early retirement option. Workers in firms in the AFP scheme who fulfill the individual requirements for previous work experience and income described in Section 4.1 have the option to retire with an AFP pension. We include a dummy variable for each age between 62 to 66 years to represent entitlement to the AFP pension. The variables are unity for those of a specific age who can retire with an AFP and zero otherwise. The local unemployment rate is a measure of the

[4] Documentation (in Norwegian) of the database can be found at this address: http://www.ssb.no/emner/03/fd-trygd/

difficultly of finding work. Thus, we include the local unemployment rate as a control variable. Arguably, local unemployment is positively correlated with early retirement. We also include a dummy variable for part-time work. Those working part-time are arguably less attached to the labour market and thus may be more likely to withdraw early from the labour market.

Many factors influence individuals' retirement behavior. Apart from those already mentioned, norms may be formed regarding early retirement. That is, previous retirement behavior may influence current retirement behavior. If early retirement is common, this may make early retirement the norm. Hence, we include the share of retired people in the county as a variable representing the norm. See Rege *et al*. (2007) for an analysis of this phenomenon.

We also include variables for married people and measures of net wealth. The relationship between marriage status and early retirement depends on various factors, such as the retirement options available and spouses' labour market status. Thus, the effect of marriage on retirement is ambiguous. The same is the case for net wealth. On the one hand, individuals with high net wealth can become self-funded retirees. On the other hand, those with high net wealth may have more interesting jobs and, hence, want to retire later. Descriptive statistics for the independent variables are reported in Table 2.

7. Empirical results

In this section, we report our estimates of the model described in Section 5. The results from separate pooled probit regressions for women and men for the choice between work and retirement are shown in Table 3. In addition to the variables explicitly reported, we also included dummy variables at the five-digit NACE level interacted with year dummies, creating year-specific industry dummy variables. This was done to capture industry-specific differences – and possibly trends – in retirement rates.

The empirical results give some support to our hypothesized relationships between technological change and early retirement. From the preceding theoretical discussion, one would expect negative coefficients on the interaction terms between age and median investment rates, which measure the continuous or anticipated rate of technological change. Higher median investment rates should, all else being equal, be associated with later retirement. Further, the negative correlation is expected to be larger for the highest ages. For men, the sign is negative and significant for all ages from 62 and above. The regression for women has negative signs for ages of 63 and above, but the coefficient estimates are not significant. We expect positive coefficients for the interaction terms between the dummy variable for changes in process technology and age, which would indicate a positive correlation between the implementation of new process technology and the probability of early retirement for older workers. For men, the coefficients are positive for ages above 60 but only significant for ages 64 and 66. The coefficients are positive for women from 62 and above, but only the coefficient for the 65-years-old variable is significant.

Let us consider further the magnitudes of the estimated effects from the probit model in Table 3. We calculate the change in probability of retirement (evaluated at sample means) for the two technological-change variables for ages 60 and above. We first calculate the difference, *ceteris paribus*, in retirement rates between individuals in firms with process changes and individuals in firms that do not implement process changes. Further, we estimate the difference in retirement rates following an increase in the median investment rate of 10 percentage points above the average median investment rate in the sample. The results are reported in Table 4. The effect of process changes is positive and significant for men aged 64 and 66; the estimated probability of workers retiring is about five percentage points higher in firms experiencing process changes. For 60-year-old men, the estimated effect is negative and significant. For the other ages, the effect is positive as expected but the coefficients are not significant. For women, the results are more mixed. Only the coefficient for women aged 65 years is positive and significant. The estimated effect is about four percentage points. The estimated effect of an increase in the median investment rate of 10 percentage points is a reduction of between one and two percentage points in the probability of retirement for men between 62 and 66. For women, although the sign is negative for the three oldest cohorts, none of the estimated coefficients are significant.

Let us now turn to the other control variables, in Table 3. As expected, the coefficient estimates for the age dummies are positive and significant for both genders. To account for the AFP early retirement scheme, we have included dummy variables for those who can withdraw from work by collecting an AFP pension. These dummy variables have positive and significant effects. The variable for health, which is based on data for sick leaves with duration of two weeks or more, has a positive coefficient, as expected, although it is only statistically significant for men. Further, all else being equal, people with more education (than compulsory schooling) are less likely to retire early, as expected.

The local unemployment rate is assumed to be one of the measures used by physicians when evaluating whether an individual is entitled to a disability pension. The local unemployment rate indicates labour market conditions and thus reflects the possibilities of finding a new job for those who are unemployed or otherwise out of the labour market. The estimated coefficient on this variable is positive and significant, as expected. The higher the unemployment rate, the more difficult it is to find a job, and the higher is the probability of early retirement. Reductions in employment at the firm level may be followed by early retirement of some older workers. We obtain a positive coefficient for this variable. Another variable that reflects the behavior of people in the same geographical area, and which may affect the probability of early retirement, is the share of retired people in the county. This variable enters significantly positive. The coefficient on part-time work indicates that part-time workers are more likely to retire early. The dummy variable for marriage is negative and significant for both women and men. The estimate of the coefficient for net wealth is not significant in either of the two regressions.

We now look at the results from regressions relating to the transition to disability and AFP pensions separately. From our sample, in the regressions relating to the transition to disability, we discard observations that involve transition from work to states other than a disability pension. For transition to the AFP, we only use observations for individuals who can withdraw from work with an AFP pension, and only the transition to an AFP pension is considered. The results from these regressions are shown in Table A.1 and Table A.2, respectively. Here, we report only the estimated effects of the technological-change variables for the highest ages. In Table 5, the results for transition to a disability pension are reported. Table 6 reports the results for transition to an AFP pension.

Table 5 shows that all the effects of process changes are positive for men. However, the effect is only significant for those who are 64 years old, cf Table 3. Men aged 64 in firms with process changes are 7.2 percentage points more likely to retire with a disability pension. For women, none of the effects are significant. The estimated effect of expected technological change is negative for the oldest cohorts for both men and women. The effects are only significant for three male age cohorts, those who are 63 to 65 years old, and vary between 1.3 and 3.4 percentage points.

The results in Table 6 show that process changes have a positive and significant effect on the probability of retiring with an AFP pension only for 66-year-old men and 65-year-old women. The estimated effect of expected technological change is negative and significant for men aged 64 and 66. The estimated effects are around one percentage point. For women, the effect is only significant for those aged 62 years old, for whom it is positive.

We also conducted a number of robustness checks. That is, we estimated the model separately for workers with different levels and types of schooling. We found that the results were similar across worker categories (results are not reported).

8. Concluding remarks

Technological changes affect the labour market in several ways. It changes the skill requirements of jobs and makes some of the existing human capital obsolete. In this paper we have analyzed the relationship between technological changes and early retirement behaviour of older workers. Older workers typically possess older vintages of skills than younger workers, and they may suffer more from technological changes. Experienced workers nevertheless have accumulated human capital making them suitable for adopting new technologies. On the other hand, to adjust to new technology, workers must invest in training and this may not be worthwhile for the oldest workers. We exploit the approach by Bartel and Sicherman (1993) to identify this effect by estimating the retirement response to technological change dependent on how often it occurs. If technological change occurs often, workers continuously invest in on-the-job training, which may insulate them from the negative effect of technological change.

We examined two hypotheses about the effects of technological changes on early retirement measured for workers from the age of 50 to mandatory age of retirement at 67. First, we examine whether workers in firms with higher rates of anticipated technological change retire later than workers in firms with lower rates of technological change. Second, we examine if (unanticipated) technological change are positively correlated with earlier retirement. We use a matched employer-employee data set with a rich set of controls for worker, firm and local labour market characteristics, and firm level measures of anticipated and not-anticipated technological change. Changes in production processes are assumed to capture unanticipated technological changes. In line with Bartel and Sicherman (1993) using industry level measures of technology and far less worker and firm controls than our study, we find a negative correlation between early retirement and technological change only for the oldest male workers (62 to 66) for those firms with high rates of *anticipated* technological change. Further, we find a higher probability of transition to retirement for workers above 60 for firms introducing new process technologies.

Figures and tables

Figure 1:
Share out of work for men aged 50 years and older by age, 1994-2001

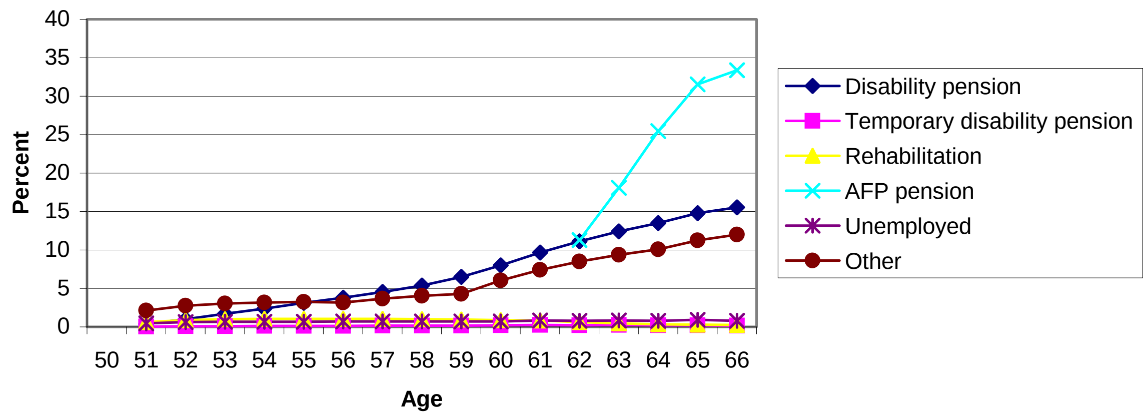

Figure 2:
Share out of work for women 50 years and older by age, 1994-2001

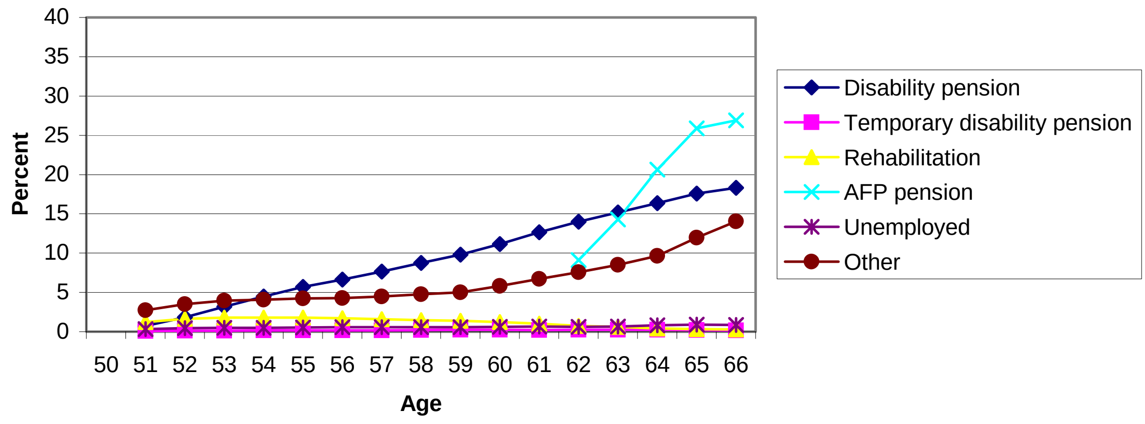

Figure 3:
Share out of work for men 50 years and older in the manufacturing industry by age, 1994-2001

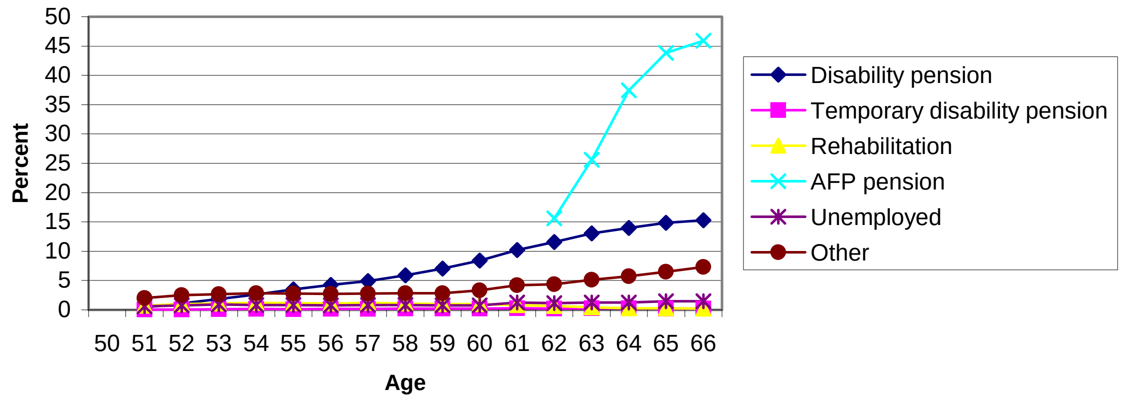

Figure 4:
Share out of work for women 50 years and older in the manufacturing industry by age, 1994-2001

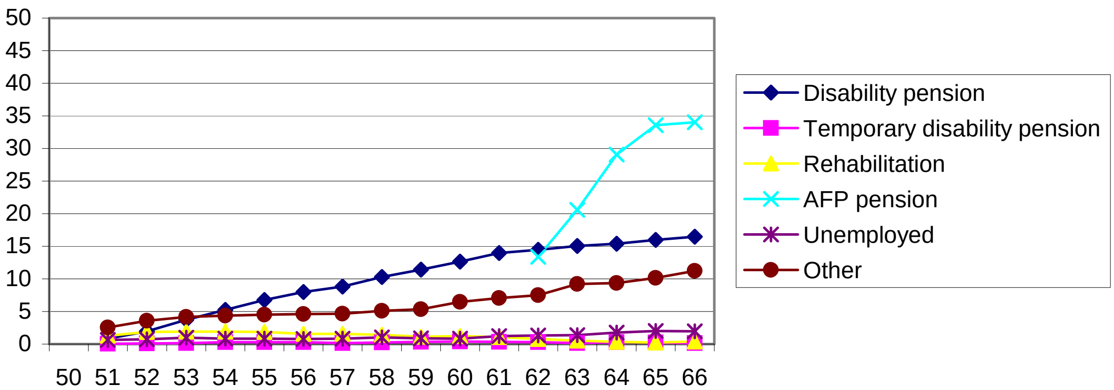

Figure 5:
Share out of work for men 50 years and older in our sample from the manufacturing industry by age, 1994-2001

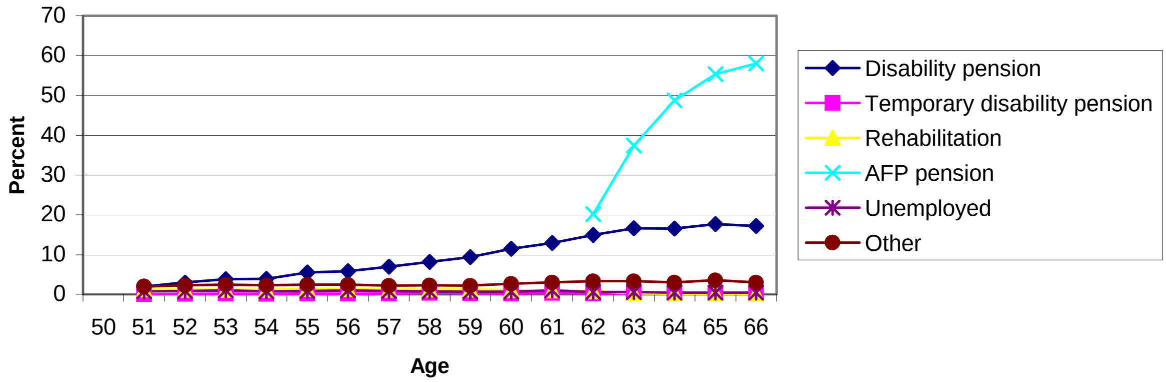

Figure 6:
Share out of work for women 50 years and older in our sample from the manufacturing industry by age, 1994-2001

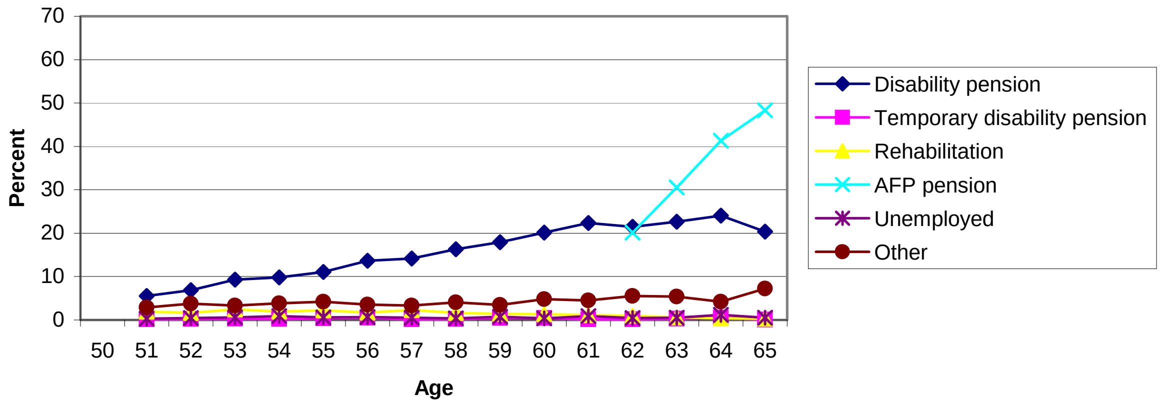

Table 1. Descriptive statistics for the firms in the sample

Year	Process changes (1=process changes, 0= no process changes	Number of firms	Mean of median investment rates. In percent
1997	0	1029	29.3
1999	0	1296	30.0
2001	0	966	30.9
1997	1	597	30.1
1999	1	352	32.4
2001	1	477	32.0

Table 2. Descriptive statistics for independent variables

	Women			
Variable	Mean	Std. Dev.	Min	Max
Median investment rate	0.31	0.26	0	11.86
Process changes	0.45	0.50	0	1
Age	56.29	3.96	51	65
Health	0.60	0.49	0	1
Education, -10 years	0.39	0.49	0	1
Education, 10 - 14 years	0.55	0.50	0	1
Education, 14 years and more	0.06	0.23	0	1
Married	0.69	0.46	0	1
Net Wealth	1.89	10.32	-44.38	1362.83
Employment change	0.62	0.49	0	1
Share retired	0.23	0.03	0.18	0.28
Local unemployment rate	0.03	0.01	0	0.18
Part time work	0.26	0.44	0	1
AFP	0.03	0.18	0	1
Obervations	28138			

	Men			
Variable	Mean	Std. Dev.	Min	Max
Median investment rate	0.28	0.20	0	5.21
Process change	0.47	0.50	0	1
Age	56.79	4.21	51	66
Health	0.49	0.50	0	1
Education, -10 years	0.32	0.46	0	1
Education, 10 - 14 years	0.54	0.50	0	1
Education, 14 years and more	0.15	0.35	0	1
Married	0.78	0.42	0	1
Net Wealth	3.48	30.21	-69.21	5846.67
Employment change	0.62	0.49	0	1
Share retired	0.17	0.02	0.13	0.22
Local unemployment rate	0.03	0.01	0	0.18
Part time work	0.03	0.17	0	1
AFP	0.05	0.21	0	1
Obervations	91718			

Table 3. Probit estimation of the probability of retiring conditional on being in work

Variables/Gender	Men	Women
Constant	-2.487* (0.5644)	-0.9704 (0.8807)
Median investment rate 51 years old	0.0012 (0.0025)	0.0031 (0.0035)
Median investment rate 52 years old	-0.0011 (0.0027)	-0.0055 (0.0032)
Median investment rate 53 years old	-0.0017 (0.0025)	-0.0044 (0.0031)
Median investment rate 54 years old	-0.0025 (0.0026)	-0.0037 (0.0027)
Median investment rate 55 years old	0.0023 (0.0021)	0.0021 (0.0029)
Median investment rate 56 years old	0.0017 (0.0024)	-0.0032 (0.0038)
Median investment rate 57 years old	0.0015 (0.0022)	-0.0064 (0.0036)
Median investment rate 58 years old	-0.0047 (0.0026)	-0.0026 (0.0022)
Median investment rate 59 years old	-0.0041 (0.0024)	0.0054* (0.0027)
Median investment rate 60 years old	0.0009 (0.0021)	-0.0023 (0.0033)
Median investment rate 61 years old	0.0008 (0.0023)	0.0021 (0.0039)
Median investment rate 62 years old	-0.0044* (0.002)	0.0035 (0.0026)
Median investment rate 63 years old	-0.0061* (0.0018)	-0.002 (0.0019)
Median investment rate 64 years old	-0.0091* (0.002)	-0.0038 (0.0037)
Median investment rate 65 years old	-0.0055* (0.0022)	-0.0008 (0.0043)
Median investment rate 66 years old	-0.0049* (0.0023)	-

Table 3 (cont.)

Variables/Gender	Men	Women
Process change 51 years old	0.0008 (0.0011)	0.0003 (0.0015)
Process change 52 years old	-0.0008 (0.001)	0.0015 (0.0014)
Process change 53 years old	-0.0011 (0.001)	0.0006 (0.0014)
Process change 54 years old	-0.0012 (0.001)	-0.0004 (0.0014)
Process change 55 years old	0.0000 (0.0009)	-0.0024 (0.0014)
Process change 56 years old	-0.0006 (0.001)	0.0005 (0.0014)
Process change 57 years old	-0.0004 (0.001)	0.0003 (0.0014)
Process change 58 years old	-0.0001 (0.0009)	-0.0019 (0.0014)
Process change 59 years old	-0.0019* (0.0009)	-0.002 (0.0015)
Process change 60 years old	-0.002* (0.0009)	-0.0003 (0.0014)
Process change 61 years old	0.0008 (0.0008)	-0.0012 (0.0014)
Process change 62 years old	0.0012 (0.0007)	0.0001 (0.0013)
Process change 63 years old	0.0011 (0.0007)	0.0009 (0.0013)
Process change 64 years old	0.0023* (0.0008)	0.0003 (0.0015)
Process change 65 years old	0.0001 (0.0009)	0.0045* (0.0017)
Process change 66 years old	0.002* (0.001)	-

Table 3 (cont.)

Variables/Gender	Men	Women
Age 52	0.2399* (0.0739)	0.2306* (0.0982)
Age 53	0.2442* (0.0734)	0.2165* (0.0991)
Age 54	0.2236* (0.0749)	0.236* (0.0971)
Age 55	0.2345* (0.0716)	0.2399* (0.0996)
Age 56	0.2754* (0.0739)	0.2852* (0.1077)
Age 57	0.2963* (0.0735)	0.3208* (0.1079)
Age 58	0.5052* (0.0754)	0.4462* (0.0985)
Age 59	0.5599* (0.0747)	0.3055* (0.1035)
Age 60	0.5957* (0.0729)	0.4996* (0.1085)
Age 61	0.6262* (0.0746)	0.5291* (0.1137)
Age 62	1.028* (0.0759)	0.7078* (0.116)
Age 63	1.6361* (0.0907)	1.2061* (0.1266)
Age 64	1.7259* (0.0953)	1.2933* (0.1459)
Age 65	2.0459* (0.1013)	1.1639* (0.1627)
Age 66	1.8897* (0.111)	-
AFP 62 years	0.8366* (0.0473)	0.8437* (0.0834)
AFP 63 years	0.5548* (0.068)	0.4813* (0.1009)
AFP 64 years	0.7282* (0.0737)	0.7454* (0.115)
AFP 65 years	0.6406* (0.0784)	0.821* (0.1283)
AFP 66 years	0.6065* (0.0918)	-

Table 3 (cont.)

Variables/Gender	Men	Women
Education, 10 - 14 years	-0.1462* (0.0141)	-0.1936* (0.0219)
Education, 15 years and more	-0.3893* (0.0239)	-0.2908* (0.0552)
Married	-0.1337* (0.015)	-0.0597* (0.0222)
Net wealth	-0.0003 (0.0005)	0.0007 (0.0011)
Share of retired in county	1.6243* (0.3349)	0.6389 (0.4711)
Local unemployment rate	3.9988* (0.6328)	4.725* (0.9992)
Part-time work	1.4749* (0.0288)	0.7674* (0.0226)
Bad health	0.6446* (0.0141)	0.6177* (0.0232)
Employment reduction	0.1473* (0.017)	0.1263* (0.0266)
Year 1999	0.7378 (0.5953)	-0.8702 (1.0038)
Year 2001	0.0135 (0.7801)	-1.7866 (1.1384)
Dummy variables for industry *Year	Yes	Yes
Log likelihood	-24144	-9887
Number of observations	91718	28138

* denotes significant at the 5 % level. Standard errors are in parentheses.

The representative individual is 52 year old, has education less than ten years, not married, working full-time, with good health and the year is 1997.

Table 4. Estimated effects of technological changes. In percentage points

Age	Process changes[1]		Median investment rates[2]	
	Men	Women	Men	Women
60	-1.4	-0.7	0.0	-0.6
61	0.7	-2.8	0.1	0.5
62	2.8	0.2	-1.0	0.5
63	2.7	1.3	-1.5	0.3
64	5.6*	0.3	-2.2	-0.4
65	0.2	4.2	-1.3	-0.1
66	4.9*	-	-1.2	-

[1] The effect of process changes estimated from the probit model.
[2] The effect of an increase in the median investment rate of 10 percentage points estimated from the probit model.

Table 5. Estimated effects of technological changes. Transitions to disability pension. In percentage points

Age	Process changes[1]		Median investment rates[2]	
	Men	Women	Men	Women
60	0.2	0.9	0.2	0.3
61	2.3	-0.9	-0.1	0.7
62	1.9	4.6	-0.7	0.0
63	4.4	-0.4	-1.3	-1.2
64	7.2	-0.8	-3.4	-0.8
65	0.4	-0.9	-1.5	-1.9
66	5.4	-	-0.8	-

[1] The effect of process changes estimated from the probit model.
[2] The effect of an increase in the median investment rate of 10 percentage points estimated from the probit model.

Table 6. Estimated effects of technological changes. Transitions to AFP pension. In percentage points

Age	Process changes[1]		Median investment rates[2]	
	Men	Women	Men	Women
62	0.7	1.0	0.0	2.6
63	0.6	7.1	-0.3	-1.3
64	1.6	-0.9	-0.9	1.8
65	0.9	19.0	-0.9	1.1
66	3.5	-	-0.9	-

[1] The effect of process changes estimated from the probit model.
[2] The effect of an increase in the median investment rate of 10 percentage points estimated from the probit model.

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Survival in the initial state and transition to other states

There are several exit routes out of work. From some of the states, there may be transitions back into work. If an individual is unemployed, on rehabilitation, or out of work for other reasons, there is a possibility of transition back into work. Conditional on being unemployed, will the person continue to be unemployed in the following year and subsequent years, or will there be transition to other states, such as employment or a disability pension? The answer to this question can be used to determine whether the out-of-work state is temporary or a final destination out of the labour market.

In Figure A.1, the survival rates for unemployment and the rates of transition to employment and disability for men are shown. It is shown that 35 percent of men aged 51 that were unemployed at the age of 50 remain unemployed. About 30 percent are in work and the rest are mainly on disability pensions or in the group 'other'. The proportion of unemployed falls to 35 percent the first year, and then to about 20 percent after four years. It then remains under 20 percent for those aged up to 60. Thereafter, the proportion of unemployed people increases, and for those aged 66, 55 percent of those who were initially unemployed in our sample remain so.

The corresponding figures for women are shown in Figure A.2. For women, the picture is similar. There are only minor differences regarding the absolute shares.

Patterns for individuals starting in rehabilitation are illustrated in Figure A.3 for men and in Figure A.4 for women. There is initially a large decrease in the share still in rehabilitation the first two years. Thereafter, the share continues to decrease, but by less. Most of the individuals in rehabilitation subsequently receive a disability pension. For 66-year-olds starting in rehabilitation, 80 percent have a disability pension. Few return to work. As in the case with unemployment, there are no significant differences between men and women, as can be seen from the two figures.

Few people are on temporary disability pensions, and they either continue to receive these pensions or subsequently get permanent disability pensions. Between 60 and 70 percent of individuals who start on a temporary disability pension end up receiving a permanent disability pension, whereas 20 to 35 percent continue on a temporary disability pension. This picture is the same for men and women. Figures A.5 and A.6 show the shares surviving in the group 'other' and the transitions to employment and disability pension for men and women, respectively. There is some transition to work, and about 40 percent of 55-year-old men are in work. Thereafter, the share in work falls as the share in the group 'other' starts to rise again. Figure A.6 shows developments for women. It differs somewhat from what we saw for men when it comes to the transition from the group 'other' into work. Fewer women leave the 'other' state for work. No more than 25 percent are in work at the ages of 53 and 54. For ages beyond 54, the share in work decreases. Thus, fewer women starting in the group 'other' leave this state. More women than men stay at home, which may in part explain these differences.

Sample

We constructed three cross-sectional samples, one for each innovation and R&D survey. For each of these surveys, we sampled individuals employed in these firms at the end of the year before the survey began and for all subsequent years including the year of the survey. The survey covers the year of the survey and the two preceding years. The cross-section sample includes individuals employed in the firms covered by the survey during the three years prior to the survey year as well as those employed in the survey year. We then classified the individuals according to whether they remained employed or retired at the end of the survey year. The numbers of observations by year and in total are shown in Table A.3.

Retirement rates for three age groups 1992-2001

In Figures A.7 and A.8, we show the developments in the shares of people on a disability pension and those on an AFP pension for the three age groups for the period 1992–2001. The share on a disability pension differs between age groups, and the oldest age groups have a higher share on a disability pension. The development for each age group is quite stable over the period. For men, there seems to be a small reduction towards the end of the observation period for the two oldest age groups, while in the age group 50–55, the share on a disability pension is about the same as in 1992 and 2001. For women, the share on a disability pension increases from 1992 to 2001, and increases for the oldest age cohorts. For the other cohorts, the share on a disability pension in 2001 is about the same as that in 1992, but the shares decrease somewhat after 1992 and then increase again up to 2001.

The share of people with an AFP pension increases in all the years for both women and men. The shares increase particularly in years in which the age limit was reduced, namely in 1997, when the age for entitlement to an AFP pension was reduced from 64 to 63 years, and in 1998, when the reduction was from 63 to 62 years.

Figures and tables

Figure A.1:
Survival in unemployment and transition to employment and disability for men by age

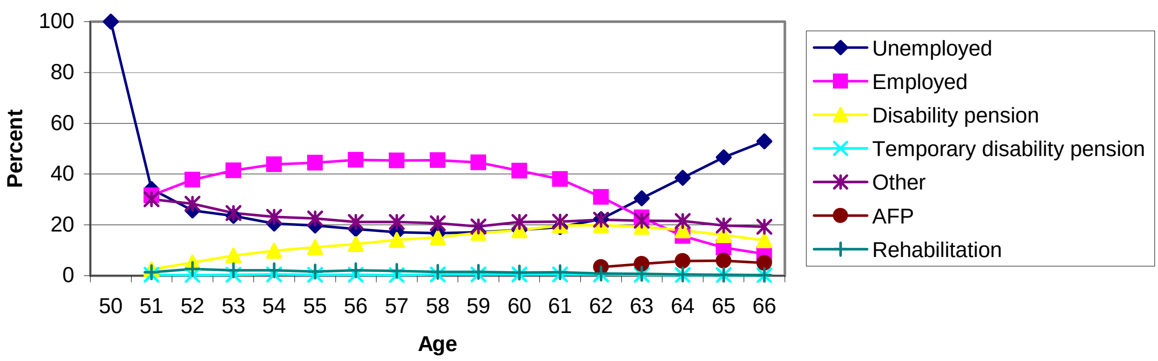
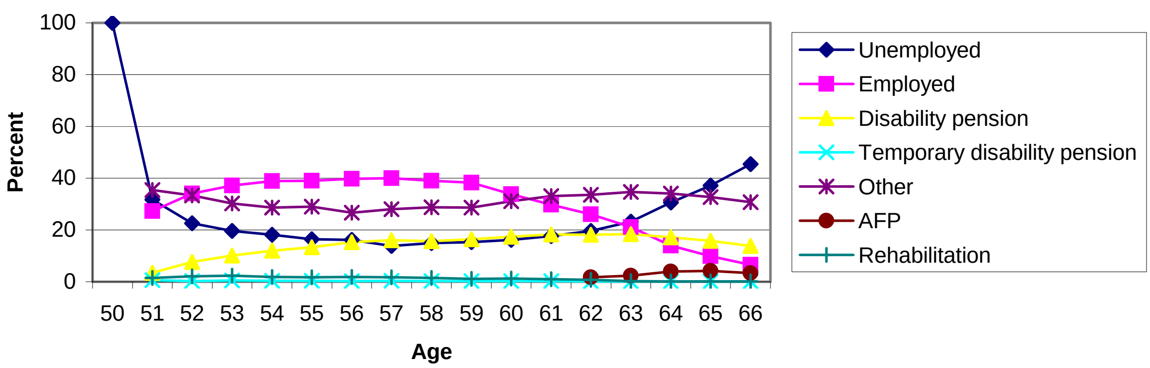


Figure A.2:
Survival in unemployment and transition to employment and disability for wpmen by age



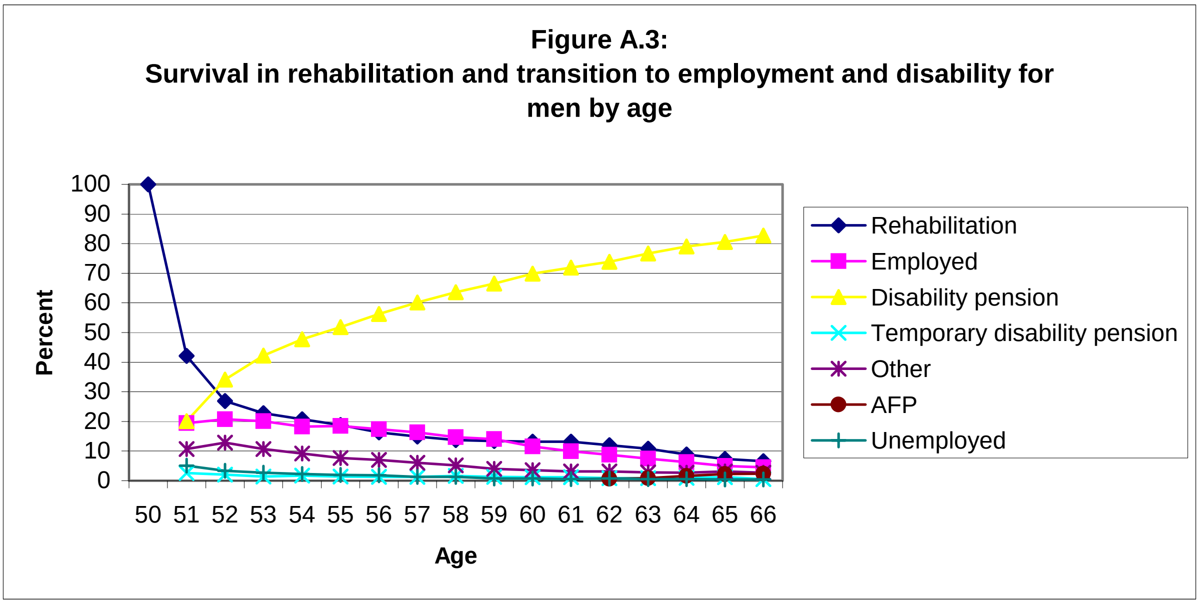


Figure A.3:
Survival in rehabilitation and transition to employment and disability for men by age
Percent
100
90
80
70
60
50
40
30
20
10
0
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66
Age
Rehabilitation
Employed
Disability pension
Temporary disability pension
Other
AFP
Unemployed

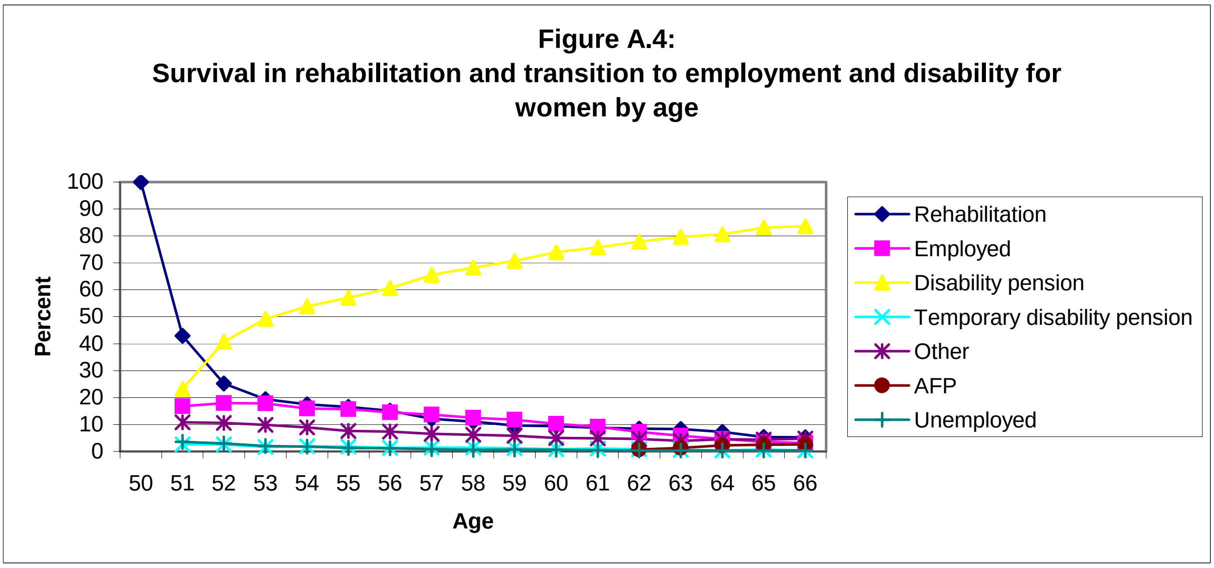


Figure A.4:
Survival in rehabilitation and transition to employment and disability for women by age
Percent
100
90
80
70
60
50
40
30
20
10
0
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66
Age
Rehabilitation
Employed
Disability pension
Temporary disability pension
Other
AFP
Unemployed

Figure A.5:
Survival in the group "other" and transition to employment and disability for men by age

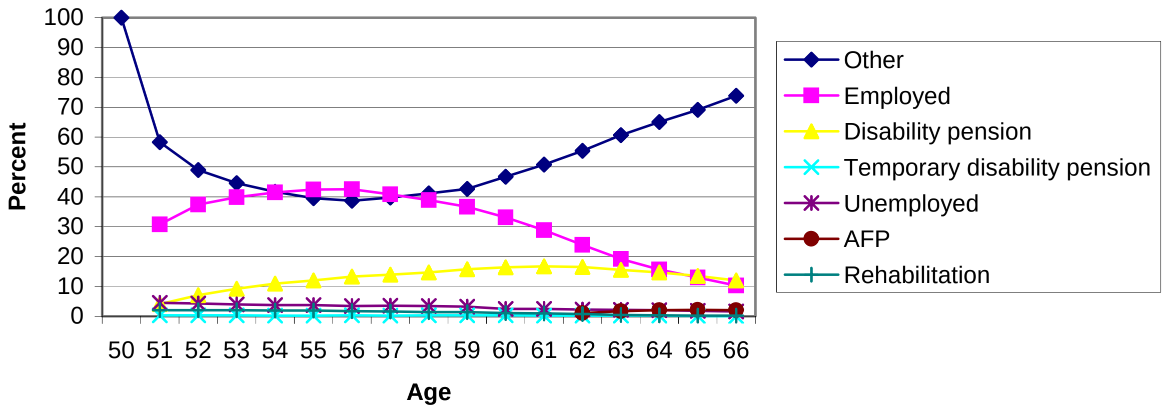


Figure A.6:
Survival in the group "other" and transition to employment and disability for women by age

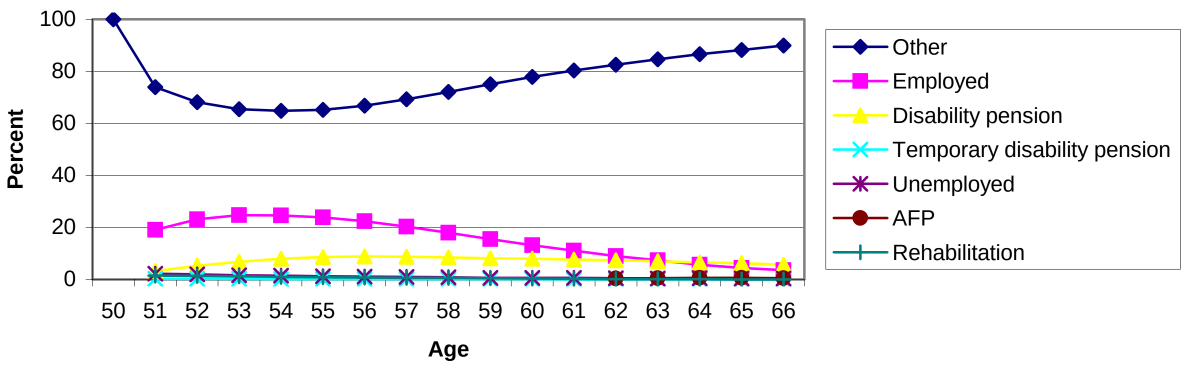


Figure A.7:
Share with disability pension and AFP pension for men aged 50-66, 1992-2001

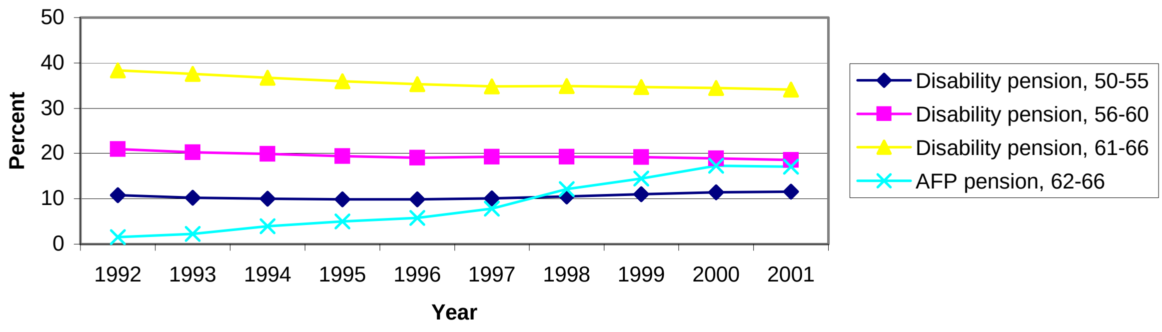


Figure A.8:
Share with disability pension and AFP pension for women aged 50-66, 1992-2001

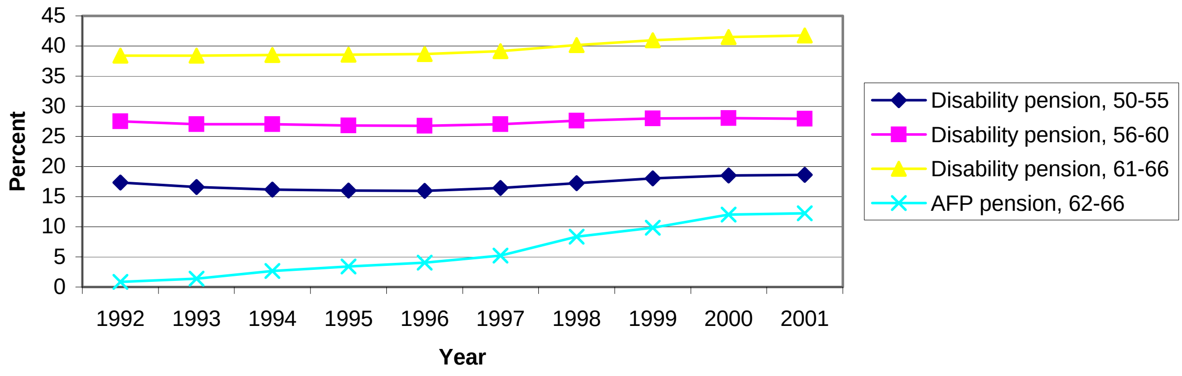


Table A.1. Transition to disability pension

Variables/Gender	Men	Women
Constant	-4.0093* (0.9796)	-1.1468 (0.8851)
Median investment rate 51 years old	-0.0005 (0.004)	-0.0017 (0.0047)
Median investment rate 52 years old	-0.0015 (0.0038)	-0.0052 (0.0036)
Median investment rate 53 years old	-0.0072 (0.0039)	-0.0031 (0.0033)
Median investment rate 54 years old	-0.0028 (0.0038)	-0.0048 (0.0044)
Median investment rate 55 years old	-0.0071* (0.0036)	0.0026 (0.0036)
Median investment rate 56 years old	-0.0011 (0.0036)	-0.0026 (0.0045)
Median investment rate 57 years old	0.0005 (0.0027)	-0.0114* (0.0048)
Median investment rate 58 years old	-0.0081* (0.0035)	-0.006 (0.0047)
Median investment rate 59 years old	-0.0059 (0.0031)	0.0029 (0.0035)
Median investment rate 60 years old	0.0019 (0.0026)	0.0018 (0.0035)
Median investment rate 61 years old	-0.0006 (0.0031)	0.0043 (0.0047)
Median investment rate 62 years old	-0.0041 (0.0037)	0.0004 (0.0039)
Median investment rate 63 years old	-0.0069* (0.0035)	-0.008 (0.0065)
Median investment rate 64 years old	-0.0129* (0.004)	-0.0063 (0.0053)
Median investment rate 65 years old	-0.0077* (0.0037)	-0.0105 (0.0074)
Median investment rate 66 years old	-0.0041 (0.0041)	missing

Table A.1 (cont.)

Variables/Gender	Men	Women
Process change 51 years old	0.0004 (0.0016)	0.0000 (0.0018)
Process change 52 years old	0.0003 (0.0014)	0.0017 (0.0017)
Process change 53 years old	0.0000 (0.0014)	-0.0001 (0.0018)
Process change 54 years old	-0.0006 (0.0015)	-0.0018 (0.0018)
Process change 55 years old	0.0005 (0.0013)	-0.0021 (0.0018)
Process change 56 years old	-0.0002 (0.0013)	-0.0002 (0.0017)
Process change 57 years old	0.0013 (0.0012)	-0.0008 (0.0018)
Process change 58 years old	0.0017 (0.0012)	-0.0023 (0.0017)
Process change 59 years old	-0.0012 (0.0012)	-0.0011 (0.0018)
Process change 60 years old	-0.0002 (0.0011)	0.0005 (0.0018)
Process change 61 years old	0.0019 (0.0011)	-0.0006 (0.0018)
Process change 62 years old	0.001 (0.0012)	0.0035 (0.0021)
Process change 63 years old	0.0024 (0.0013)	-0.0003 (0.0022)
Process change 64 years old	0.0035* (0.0014)	-0.0007 (0.0024)
Process change 65 years old	0.0002 (0.0015)	-0.0005 (0.0028)
Process change 66 years old	0.0031 (0.0018)	missing

Table A.1 (cont.)

Variables/Gender	Men	Women
Age 52	0.2375* (0.1069)	0.1238 (0.1217)
Age 53	0.2805* (0.1081)	0.0291 (0.1224)
Age 54	0.1667 (0.1099)	0.1013 (0.1302)
Age 55	0.3815* (0.1065)	0.0336 (0.1275)
Age 56	0.3986* (0.1075)	0.2317 (0.1326)
Age 57	0.3754* (0.1030)	0.3173* (0.1354)
Age 58	0.6531* (0.1057)	0.4624* (0.1358)
Age 59	0.7589* (0.1035)	0.3367* (0.1293)
Age 60	0.8475* (0.1018)	0.5082* (0.1319)
Age 61	0.9357* (0.1074)	0.6393* (0.1411)
Age 62	1.4597* (0.1140)	0.7058* (0.1567)
Age 63	1.8970* (0.1282)	1.2262* (0.1902)
Age 64	1.9317* (0.1351)	1.3088* (0.1864)
Age 65	2.2404* (0.1370)	1.2040* (0.2306)
Age 66	1.9946* (0.1527)	missing
AFP 62 years	-0.1671* (0.0736)	0.0533 (0.1271)
AFP 63 years	-0.4829* (0.0893)	-0.2564 (0.1408)
AFP 64 years	-0.3084* (0.0984)	-0.2178 (0.1542)
AFP 65 years	-0.6728* (0.1015)	-0.3284 (0.1783)
AFP 66 years	-0.7749* (0.1214)	missing

Table A.1 (cont.)

Variables/Gender	Men	Women
Education, 10 - 14 years	-0.1979* (0.0198)	-0.2461* (0.0281)
Education, 15 years and more	-0.6005* (0.0423)	-0.4965* (0.0840)
Married	-0.1107* (0.0213)	-0.1630* (0.0288)
Net wealth	-0.0012 (0.0010)	-0.0021 (0.0026)
Share of retired in county	3.2304* (0.4836)	1.7160* (0.6108)
Local unemployment rate	3.0479* (0.8942)	4-0256* (1.2379)
Part-time work	1.9747* (0.0355)	1.0036* (0.0290)
Bad health	1.2030* (0.0270)	0.8671* (0.0334)
Employment reduction	0.0661* (0.0239)	0.1041* (0.0339)
Year 1999	1.1931 (1.0082)	-1.0270 (1.1161)
Year 2001	0.5755 (1.1670)	-0.0866 (1.1644)
Dummy variables for industry *Year	Yes	Yes
Log likelihood	-11,246	-5,271
Number of observations	74,349	22,442

* denotes significant at the 5 % level. Standard errors are in parentheses.

The representative individual is 52 year old, has education less than ten years, not married, working full-time, with good health and the year is 1997.

Table A.2. Transition to AFP pension

Variables/Gender	Men	Women
Constant	-2.4767* (0.6387)	-1.3203* (0.5273)
Median investment rate 62 years old	-0.0009 (0.0026)	0.0135* (0.0052)
Median investment rate 63 years old	-0.0034 (0.0022)	-0.0006 (0.0063)
Median investment rate 64 years old	-0.0072* (0.0024)	-0.0074 (0.0053)
Median investment rate 65 years old	-0.0052 (0.0028)	0.0043 (0.0069)
Median investment rate 66 years old	-0.006* (0.0028)	missing
Process change 62 years old	0.0021 (0.0011)	0.0006 (0.0024)
Process change 63 years old	0.0008 (0.0009)	0.0035 (0.0021)
Process change 64 years old	0.0015 (0.0010)	-0.0004 (0.0023)
Process change 65 years old	0.0006 (0.0011)	0.0075* (0.0025)
Process change 66 years old	0.0025* (0.0012	missing
Age 63	0.5620* (0.0792)	0.4688* (0.1948)
Age 64	0.9093* (0.0838)	1.0631* (0.1964)
Age 65	1.1192* (0.0917)	0.8577* (0.2142)
Age 66	0.9606* (0.0985)	missing
Education, 10 - 14 years	-0.1459* (0.0306)	-0.2030* (0.0724)
Education, 14 years and more	-0.5893* (0.0437)	-0.4126* (0.1653)

Table A.2 (cont.)

Variables/Gender	Men	Women
Married	0.0158	0.4355*
	(0.0343)	(0.0705)
Net wealth	-0.0028*	0.0061
	(0.0014)	(0.0080)
Share of retired in county	1.4192*	0.2274
	(0.7108)	(1.5528)
Local unemployment rate	5.7117*	7.2906
	(1.4140)	(3.7461)
Part-time work	0.7307*	0.2048*
	(0.0663)	(0.0754)
Bad health	0.0694*	0.0971
	(0.0274)	(0.0669)
Employment reduction	0.2601*	0.3677*
	(0.0374)	(0.0930)
Year 1999	0.8149	-0.7434
	(0.8753)	(1.0905)
Year 2001	1.2634	-0.1161
	(1.0846)	(1.1111)
Dummy variables for industry *Year	Yes	Yes
Log likelihood	-6,214	-1,154
Number of observations	10,796	2,012

* denotes significant at the 5 % level. Standard errors are in parentheses.

The representative individual is 52 year old, has education less than ten years, not married, working full-time, with good health and the year is 1997.

Table A.3. Observations by year

Year	Observations
1997	44,743
1999	47,220
2001	48,957
Total	140,920